

AMENDMENTS TO THE CLAIMS

This listing of the claims will replace all prior versions and listings of claims in the application:

Listing of Claims

1. (original) A method of maintaining a predetermined phase relationship between a periodic output signal and a periodic input signal, said method comprising:  
counting signals that each indicate a phase difference outside said phase relationship between said output signal and said input signal; and  
shifting the phase of said output signal to reestablish said phase relationship in response to said counting signals reaching a count threshold, said count threshold greater than one.

2. (previously presented) The method of claim 1 wherein:  
said counting comprises counting signals indicating a lagging phase difference; and  
said shifting comprises shifting the phase of said output signal to reestablish said phase relationship in response to said counting signals reaching a lagging phase count threshold, said count threshold greater than one.

3. (previously presented) The method of claim 1 wherein:  
said counting comprises counting signals indicating a leading phase difference; and  
said shifting comprises shifting the phase of said output signal to reestablish said phase relationship in

response to said counting signals reaching a leading phase count threshold, said count threshold greater than one.

4. (previously presented) The method of claim 1 wherein said counting comprises:

counting signals that indicate a lagging phase difference outside said phase relationship between said output signal and said input signal;

counting signals that indicate a leading phase difference outside said phase relationship between said output signal and said input signal; and

taking the difference between said counted signals indicating a lagging phase difference and said counted signals indicating a leading phase difference.

5. (previously presented) The method of claim 4 wherein said shifting comprises shifting the phase of said output signal to reestablish said phase relationship in response to said difference reaching said count threshold, said count threshold greater than one.

6. (currently amended) Apparatus comprising:

a phase detector having a first input operative to receive a periodic reference signal, a second input, and an output, said detector operative to detect phase differences between respective signals received at said first and second inputs;

a ~~thermometer register~~ digital low pass filter having an input, a multi-bit register, and an output, said ~~register~~ filter input coupled to said phase detector output, said ~~register~~ filter providing an output signal in response to all bits of said register having a same logical binary value; and

a variable-delay buffer having a first input operative to receive said reference signal, a second input coupled to said ~~register~~ filter output, a plurality of delay elements, and an output operative to provide an output signal, said output signal coupled to said second input of said phase detector, said buffer operative to select a delay with respect to said reference signal at which to output said output signal in response to said ~~register~~ filter output signal.

7. (previously presented) The apparatus of claim 6 wherein said apparatus comprises a delay lock loop.

8. (previously presented) The apparatus of claim 6 wherein said apparatus comprises a memory device.

9. (previously presented) The apparatus of claim 6 wherein said apparatus comprises a dynamic random access memory.

10. (previously presented) The apparatus of claim 6 wherein said apparatus comprises a synchronous dynamic random access memory.

11. (previously presented) The apparatus of claim 6 wherein said phase detector comprises a flip-flop clocked by said reference signal, said flip-flop coupled to receive said buffer output signal and providing an output signal indicative of whether said buffer output signal is leading or lagging said reference signal.

12. (currently amended) The apparatus of claim 6 wherein said ~~thermometer~~ register comprises a shift register.

13. (currently amended) The apparatus of claim 6 wherein:

the most significant bits of said ~~thermometer~~ register are initialized to a same logical binary value, said most significant bits representing half of all bits in said ~~thermometer~~ register; and

the least significant bits of said ~~thermometer~~ register are initialized to the other logical binary value, said least significant bits representing the other half of all bits in said ~~thermometer~~ register.

14. (previously presented) The apparatus of claim 13 wherein:

said most significant bits are initialized to logical ones; and

said least significant bits are initialized to logical zeros.

15. (currently amended) The apparatus of claim 6 wherein:

said ~~thermometer~~ register is shifted in a first direction in response to a phase detector output signal indicating a lagging buffer output signal; and

said ~~thermometer~~ register is shifted in a second direction opposite said first direction in response to a phase detector output signal indicating a leading buffer output signal.

16. (previously presented) The apparatus of claim 15 wherein:

said shift in a first direction comprises shifting in a bit having a logical binary value; and

said shift in a second direction comprises shifting in a bit having the other logical binary value.

17. (currently amended) The apparatus of claim 6 wherein said ~~register~~ filter output signal comprises:

a first ~~register~~ filter output signal indicating that said delay should be increased; and  
a second ~~register~~ filter output signal indicating that said delay should be decreased.

18. (currently amended) The apparatus of claim 6 wherein said ~~register~~ filter output signal comprises:

a first ~~register~~ filter output signal that is output in response to said ~~thermometer~~ register having all logical ones; and

a second ~~register~~ filter output signal that is output in response to said ~~thermometer~~ register having all logical zeros.

19. (currently amended) Apparatus comprising:

a phase detector having ~~two outputs~~ an output,  
a first input operative to receive a first periodic signal,  
and a second input operative to receive a second periodic signal, said detector generating a first output signal at ~~said first output~~ in response to detecting said second periodic signal with a leading phase difference outside a predetermined phase relationship with said first periodic signal and generating a second output signal at ~~said second output~~ in response to detecting said second periodic signal with a lagging phase difference outside said phase relationship;

means for determining the number of said generated first and second signals, said means generating a third signal in response to said first signal being greater in number than said second signal by a first predetermined number and generating a fourth signal in response to said second

signal being greater in number than said first signal by a second predetermined number; and

a variable-delay buffer coupled to said means, said buffer adjusting the phase of said second periodic signal in response to receiving one of said third and fourth signals.

20. (previously presented) The apparatus of claim 19 wherein said apparatus comprises a delay lock loop.

21. (previously presented) The apparatus of claim 19 wherein said apparatus comprises a memory device.

22. (previously presented) The apparatus of claim 19 wherein said apparatus comprises a dynamic random access memory.

23. (previously presented) The apparatus of claim 19 wherein said apparatus comprises a synchronous dynamic random access memory.

24. (previously presented) The apparatus of claim 19 wherein:

said third signal causes said buffer to adjust said phase by increasing a delay between said first and second periodic signals; and

said fourth signal causes said buffer to adjust said phase by decreasing a delay between said first and second periodic signals.

25. (previously presented) The apparatus of claim 19 wherein said phase relationship comprises a zero phase difference between said first and second periodic signals.

26. (currently amended) A memory device comprising:  
a phase detector operative to detect the phase difference between two signals, said phase detector having an output;

a low pass filter having an input coupled to said phase detector output, said filter having an output and operative to output a first signal in response to receiving from said phase detector a first predetermined number of a first ~~type of~~ detector output signal and operative to output a second signal in response to receiving from said phase detector a second predetermined number of a second ~~type of~~ detector output signal, said first and second predetermined numbers each greater than one; and

a delay buffer having an input coupled to said filter output and having a second input operative to receive one of said two signals, said delay buffer operative to output the other of said two signals and operative to increase or decrease a phase difference between said two signals in response to and in accordance with receipt of either said first or said second signal from said filter output.

27. (previously presented) The memory device of claim 26 wherein said memory device comprises a dynamic random access memory.

28. (previously presented) The memory device of claim 26 wherein said memory device comprises a synchronous dynamic random access memory.

29. (currently amended) The memory device of claim 26 wherein:

said first predetermined number is a predetermined positive ~~net~~ number of received said first ~~type~~

detector output signals greater than received said second ~~type~~  
detector output signals; and

said second predetermined number is a  
predetermined positive ~~net~~ number of received said second ~~type~~  
detector output signals greater than received said first ~~type~~  
detector output signals.

30. (currently amended) The memory device of  
claim 26 wherein said first ~~type~~ detector output signal  
indicates a lagging phase difference and said second ~~type~~  
detector output signal indicates a leading phase difference.

31. (previously presented) The memory device of  
claim 26 wherein said first signal output from said low pass  
filter is a logical one signal and said second signal output  
from said low pass filter is a logical zero signal.

32. (previously presented) The memory device of  
claim 26 wherein said low pass filter output comprises two  
signal leads, said first signal output on one of said two  
leads and said second signal output on the other of said two  
leads.

33. (previously presented) A memory device  
comprising:

means for counting signals that each indicate a  
phase difference outside a predetermined phase relationship  
between a periodic output signal and a periodic input signal;  
and

means for shifting the phase of said output  
signal to reestablish said phase relationship in response to  
said counting signals reaching a count threshold, said count  
threshold greater than one.